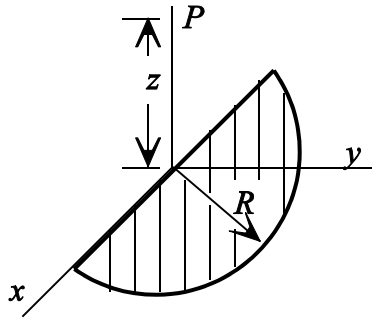
Phys. 221 – E & M- I – Test 1 – Feb. 20, 2004

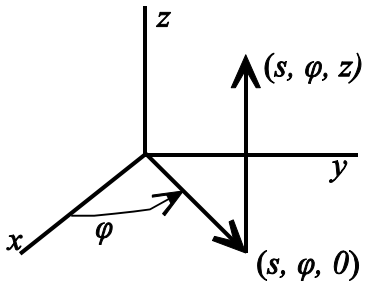
1. (25 pts) Find the electric field $\vec{E}(z)$ at a distance *z* above a charge distribution which consists of a half disk of radius R lying in the *xy* plane. The half disk has a surface charge distribution given by $\sigma = \sigma_0 \sin\phi$, where σ_0 is a constant.



Note:

$$\sin^2(\alpha) = \tfrac{1}{2}(1 - \cos(2\alpha)) \quad \cos^2(\alpha) = \tfrac{1}{2}(1 + \cos(2\alpha))$$

2. (25 pts) An electrostatic field is given by $\vec{E} = C\left[(3s^2z^2\sin\phi)\hat{s} + (s^2z^2\cos\phi)\hat{\phi} + (2zs^3\sin\phi)\hat{z}\right]$, where C is a constant with the appropriate units.



a) Verify that this is a possible electrostatic field.

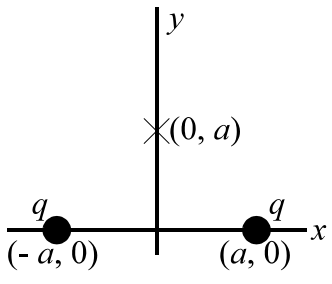
b) Find the potential, using the *origin* as your reference point. Use the indicated path from the origin to the point; that is, go from *0* to *s* along the path with φ fixed and then from *0* to *z* up to the point.

3. (25 pts) A long cylinder of radius *R* carries a volume charge density that is proportional to the distance from the axis. The volume charge density is given by $\rho(s) = As; \quad 0 < s < R$, where *A* is a constant.

a) Find the electric field as a function of *s* inside and outside the long cylinder.

b) Find the electric potential as a function of *s* inside and outside the cylinder. Use $s = R$ as the reference point for the electric potential.

4. (25 pts) a) Two charges are situated symmetrically about the *y* axis in the *xy* plane as shown. One charge *q* is located at (*x*, *y*) = (*a*, 0) and the other charge *q* is located at (- *a*, 0). How much work does it take to bring in another charge 2*q*, from far away and place it at the location (0, *a*)?



b) How much work does it take to assemble the whole configuration of three charges?